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ANNUAL REPORT

OF THE

INSPECTOR

OF

Gas Meters and Illuminating Gas.

JANUARY, 1899.

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Commonwealth of Massachusetts.

OFFICE OF INSPECTOR OF GAS AND GAS METERS,
32 HAWLEY STREET, BOSTON, MASS., Jan. 30, 1899.

Hon. WM. M. OLIN, *Secretary of the Commonwealth.*

SIR: — I have the honor to hand you herewith the report of the Inspector of Gas Meters and of Illuminating Gas for 1898.

Respectfully,

CHAS. D. JENKINS.

REPORT.

OFFICE OF GAS INSPECTION, 32 HAWLEY STREET,
BOSTON, MASS., Jan. 25, 1899.

To the Honorable Senate and the House of Representatives.

The following report is submitted by the Inspector of Gas Meters and of Illuminating Gas: —

For the year ending Dec. 31, 1898, there were 649 gas inspections made, 23,131 gas meters inspected, 10 meter provers graduated, and several special examinations of gases made for heating value and composition.

Of the meters tested, 22,594 were either new or had just been repaired, and generally were found to register correctly, a very small number being returned for adjustment.

In testing meters the very important question of temperatures must be kept prominently in mind. It is not sufficient to take a meter into a proving room, and, connecting with a prover, to run the meter without further precautions. A difference of five degrees F. in any of the conditions of testing will be likely to make an error of one per cent. in the proof of the meter. The meter should be kept in the proving room long enough, ten to twenty hours, to insure its acquiring the room temperature. In order to make a satisfactory test, the temperatures of the air in the room and the air and water in the prover as well as of the meter should agree within two degrees.

The remaining 537 meters belong to the class of "complaints." This class comprises meters which are suspected of being inaccurate by the consumer or gas company. By the provisions of Public Statutes, chapter 61, section 12, these meters are reinspected by the State inspector, on complaint of either party. The following results do not show much difference from former years, as shown in table. One meter would neither pass gas nor register; eleven would

pass gas but would not register; of the remaining 525 meters, the average error was 1.10 per cent. fast, the law allowing a meter to be stamped as correct that does not vary more than two per cent. from the standard measure. Two hundred and thirty-five meters, 43.76 per cent. of the total number, were fast, the average error being 4.97 per cent.; 42 were slow, the average error being 15.65 per cent. One hundred and sixty-seven of the fast meters were less than 5 per cent. fast, 58 were between 5 and 10 per cent., 9 between 10 and 15 and 1 between 15 and 20 per cent. fast. Fourteen meters were less than 5 per cent. slow, 16 were between 5 and 10 per cent., 6 between 10 and 15, and 2 between 15 and 20 per cent. slow; there were one each 20, 38, 145 and 190 per cent. slow. Two hundred and forty-eight meters were correct within the legal limits. These statements refer to the register of meters; that is, if a meter registers 200 feet of gas and has actually passed only 100 feet, it registers 100 per cent. fast.

YEAR.	Fast Meters.		Slow Meters.		Correct Meters.	Total.	
	Number.	Per Cent.	Number.	Per Cent.		Number.	Per Cent. Error.
1890,	64	5.32	20	23.60	134	218	0.60 slow.
1891,	52	4.74	34	10.03	144	230	0.41 slow.
1892,	105	5.67	49	9.28	190	344	0.41 fast.
1893,	197	5.10	46	9.30	284	527	1.23 fast.
1894,	217	4.70	55	8.56	327	604	0.99 fast.
1895,	301	4.73	93	9.72	549	957	0.40 fast.
1896,	477	4.87	113	8.41	602	1,200	1.22 fast.
1897,	183	4.98	31	12.39	220	443	1.36 fast.
1898,	235	4.97	42	15.65	248	537	1.10 fast.

As usual, there have been complaints received of large gas bills, which to the consumer were unaccountable; in such cases a little time devoted to reading the meter and

looking after the burners might satisfy the consumer. It ought to be a common acquirement to read a gas meter, and for this purpose meters should be set in light, easily accessible places, and not higher than six feet. Placing meters near the ceiling of warm halls or rooms is bad for the meters, and renders it difficult to read them or to shut off the gas in an emergency. It is a simple matter to read a meter, as it is only necessary to read, from left to right, the smaller figures, or those the hands have passed, reading the figure the hand at the right is nearer. Adding two ciphers to these figures gives the reading in cubic feet; subtracting from this reading the previous one gives the amount of gas that has passed in the interval. The gas meter has no power of itself to register; it cannot register unless gas goes through it; if gas goes though the meter, the gas must be either leaking, unconsumed, through the fixtures or pipes, or be burning, either economically or wastefully. To test for a leak, after making sure all burners are shut off, watch the testing hand on the small circle at top of dial. This hand makes a revolution for two, five, or more feet, according to size of meter. By noting the position of the hand at the beginning of test and again every five or ten minutes, it is easily determined whether the pipes are tight and no gas is being registered, or whether there is a leak, and how much. If this test shows no leak, it follows that all gas that is registered must go through the burners. By keeping account of the number of burners and number of hours used day by day, the monthly amount of gas can be estimated, if the gas consumed per hour by each burner is known. To find this, the same experiment or testing hand is used, and the time required to make a revolution of two or more feet is noted, and the rate per hour calculated. It is a most satisfactory method of checking the amount of gas used to read the meter at regular intervals, as daily or weekly, thus keeping track of the rate at which the gas is being used and registered.

There are many varieties of gas burners, and many require careful treatment to prevent a large and unnecessary loss of gas. A test recently made gave a candle-power of

21.3 when burning 5 feet per hour, and 20.8 when burning 12.3 feet. This change was made by simply opening the stop cock wider and allowing the gas to blow. Open-flame burners should show a smooth flame, without "fingers" (visible streams of gas in the body of the flame) or "ears" (thin, pointed flames, shooting out from corners of flame). The remedy for these wasteful methods of burning is to shut down the gas supply at stop cock, or to use a good governor or check burner. It sometimes happens that by increasing the use of gas or because of pipes which are too small or are partially stopped up, the consumer does not have pressure enough to properly supply his burners with gas enough to give the best light. After remedying this defect by larger pipes or a new service pipe, thus obtaining sufficient pressure to properly operate the burners, more gas is likely to be consumed unless care is used. This increase, as the others, can be detected and regulated by a frequent reading of the meter.

To the 68 gas companies of the last report has been added the Framingham Gas, Fuel and Power Company. These 69 companies had the gas supplied by them tested at irregular intervals during the year, no notice whatever being given of an intended visit. The number of inspections depends on the amount of gas supplied, each company having two inspections yearly, and an additional one for each six million feet of gas supplied, until the inspections become weekly. The usual tests comprise determination of candle-power, sulphur, ammonia and sulphuretted hydrogen. The law requires the candle-power to be 16 at least, restricts the amount of sulphur to 20 grains and ammonia to 10 grains per 100 feet of gas, and prohibits sulphuretted hydrogen.

In the following table are given the number of inspections and average candle-powers, and average amounts of sulphur and ammonia, as determined by the regular tests made by the inspector and assistant during the year. These results were furnished, on request, to the Board of Gas and Electric Light Commissioners from time to time during the year.

Larger Companies.

Number of Inspections made.	NAME OF PLACE OR COMPANY.	CANDLE-POWER.			GRAINS PER ONE HUNDRED FEET OF GAS OF—	
		Average.	Highest.	Lowest.	Sulphur.	Ammonia.
53	Boston, . .	25.88	27.8	24.1	7.16	1.—
52	Brookline, . .	25.57	27.9	21.6	7.63	1.—
6	Brockton, . .	16.77	17.9	15.4	15.05	1.—
35	Cambridge, .	18.01	19.1	17.1	13.90	1.—
20	Charlestown, .	19.72	21.9	18.4	12.38	1.—
6	Chelsea, . .	17.78	18.4	17.1	10.29	1.—
29	Dorchester, . .	25.85	28.1	24.3	7.15	1.—
9	East Boston, .	17.81	19.5	13.4	8.35	2.28
17	Fall River, . .	22.26	25.8	20.6	6.89	1.—
5	Fitchburg, . .	19.38	21.0	18.7	11.04	1.—
5	Gloucester, . .	17.46	18.0	16.0	11.08	1 —
15	Haverhill, . .	24.75	26.2	21.5	7.49	1.—
11	Holyoke, . .	20.19	22.1	19.1	5.63	7.32
13	Jamaica Plain, .	17.66	19.0	16.3	13.07	3.49
16	Lawrence, . .	20.12	21.3	19.1	9.99	1.—
49	Lowell, . .	21.66	24.3	19.2	10.15	1.16
23	Lynn, . . .	19.70	21.3	18.2	11.62	1.—
11	Malden, . .	18.99	21.2	17.8	11.70	1.—
11	New Bedford, .	20.70	22.7	18.2	12.04	1.38
16	Newton, . .	18.37	19.5	17.3	11.71	1.—
5	Northampton, .	19.67	20.5	19.4	19.62	4.20
6	North Adams, .	19.47	22.3	17.8	7.90	3.07
4	Pittsfield, . .	25.60	28.0	23.4	3.77	1.—
37	Roxbury, . .	25.48	27.1	19.7	7.26	1.—
9	Salem, . .	18.47	19.3	16.8	11.73	4.48
18	South Boston, .	25.54	27.7	24.1	7.16	1.—
21	Springfield, . .	20.10	22.0	18.7	11.69	1.—
8	Taunton, . .	18.31	19.2	17.6	9.67	13.21
6	Waltham, . .	17.82	18.3	17.0	7.05	5.26
36	Worcester, . .	20.78	21.9	19.9	11.91	1.—
	Average, .	20.65	–	–	10.02	2.09

Smaller Companies.

Number of inspections made.	NAME OF PLACE OR COMPANY.	Candle-power.	GRAINS PER ONE HUNDRED FEET OF GAS OF —	
			Sulphur.	Ammonia.
3	Adams, ...	21.17	8.80	1.—
3	Amesbury, ...	23.17	13.97	1.—
3	Arlington, ...	18.83	6.63	1.60
2	Athol, ...	23.60	6.60	1.—
3	Attleborough, . . .	19.77	6.30	1.—
3	Beverly, ...	19.47	11.73	8.07
3	Chicopee, ...	22.13	9.10	1.—
3	Clinton, ...	17.03	12.17	1.37
2	Danvers, ...	19.40	12.70	3.85
3	Dedham, ...	17.27	12.30	1.57
2	Easthampton, . . .	19.60	9.00	3.75
3	Framingham, . . .	20.30	9.83	1.—
2	Greenfield, ...	18.45	9.95	5.25
2	Ipswich, ...	24.55	5.05	1.—
2	Marblehead, ...	17.45	8.35	1.—
3	Marlborough, . . .	18.00	11.77	1.—
3	Milford, ...	18.67	6.60	3.07
2	Nantucket, ...	18.60	12.55	3.55
2	Natick, ...	17.80	12.70	1.—
3	Newburyport, . . .	18.53	9.75	1.—
2	Norwood, ...	18.75	8.60	5.55
3	No. Attleborough, . . .	17.07	13.25	1.03
2	Plymouth, ...	18.40	10.15	4.25
3	Quincy, ...	19.20	9.33	2.27
2	Southbridge, ...	23.30	5.15	1.—
3	Spencer, ...	23.23	8.23	1.—
2	Stoneham, ...	21.95	3.60	1.—
3	Wakefield, ...	18.43	8.20	1.07
2	Ware, ...	19.85	4.20	5.20
2	Webster, ...	18.65	14.35	1.—
3	Westfield, ...	18.43	6.03	1.—
4	Woburn, ...	17.80	8.02	1.—
	Average, ...	19.66	9.22	2.03

Companies making Gas from Petroleum.

Number of Inspections made.	NAME OR PLACE OF COMPANY.	Candle-power.
2	Amherst,	40.45
2	Gardner,	44.25
2	Leominster,	28.00
2	Lexington,	25.10
2	Middleborough,	25.50
2	Stoughton,	48.65
2	Williamstown,	54.20
	Average,	38.02

The comparisons with previous years of candle-powers of companies making coal, water and mixed coal and water gases are given in the following table: —

	1898.	1897.	1896.	1895.	1894.
All companies but oil gas: —					
Average candle-power,	20.14	19.71	19.07	19.30	19.31
Average sulphur, grains per 100 feet.	9.61	9.54	8.85	9.29	9.47
Average ammonia, grains per 100 feet.	2.06	2.29	1.79	2.46	2.57
Average candle-power: —					
Thirty-six coal gas companies,	18.43	17.92	17.61	18.03	17.98
Seventeen water gas companies,	23.72	23.66	22.77	23.28	23.64
Nine mixed coal and water gas companies.	20.21	19.79	19.39	19.65	19.63
Seven petroleum oil gas companies.	38.02	38.11	35.41	33.00	31.48

At Plymouth and Gloucester the tests were made at the offices at the works; at Westfield the tests were made at the

works, as formerly. The first two places have no up-town offices, and at Westfield the accommodations are better than at the small up-town office.

The following tables show the violations of the law during the year: —

Deficient candle-power: —

Dedham, December 27,	15.0
East Boston, May 20,	15.8
East Boston, July 9,	13.4
Brockton, June 4,	15.4

Excess of sulphur (grains per 100 cubic feet): —

Cambridge, April 13,	24.8
Cambridge, August 17,	20.4
Lowell, May 5,	22.3
Malden, April 28,	20.1
Northampton, May 4,	45.1
Webster, April 13,	20.2

Excess of ammonia (grains per 100 cubic feet): —

Holyoke, May 17,	19.6
Jamaica Plain, October 7,	18.5
Lowell, August 6,	10.8
Norwood, June 28,	10.3
Taunton, December 31,	86.3
Waltham, October 1,	11.8

Sulphuretted hydrogen present: —

Amesbury, March 23.	Quincy, October 20.
Amesbury, October 14.	Quincy, December 6.
Amesbury, December 8.	Spencer, April 2.
Arlington, February 23.	Spencer, December 30.
Athol, December 21.	Stoneham, November 17.
Fall River, December 31.	Taunton, December 8.
Ipswich, December 23.	Amherst, March 5.
Marblehead, December 13.	Leominster, December 28.
North Adams, October 5.	Williamstown, April 27.
Plymouth, December 6.	Framingham, December 14.

At East Boston the low candle-powers were consecutive, and due to poor coal; an analysis of the July 9th sample appears in the table of analyses.

The sulphurs at Cambridge were not consecutive.

The sulphuretted hydrogens at Amesbury and Quincy were consecutive, and a fine became due the town of Amesbury. At Spencer the tests were not consecutive; while at Amherst the test of December 16 showed the gas clean.

Several analyses have been made, and are given in the following table. The Framingham sample is that of the gas furnished by the Framingham Gas, Fuel and Power Company, which formerly furnished a fuel gas, a non-luminous water gas made by the Loomis process, but a year ago began enriching and furnishing an illuminating gas. The nitrogen and carbonic acid are noticeably high. The Roxbury sample was analyzed on account of the low candle-power. The Cambridge sample was presented by the Board of Gas and Electric Light Commissioners from a consumer, and analyzed for the Board. The East Boston gas analyzed was of low candle-power, and indicated, not accidental impurities, but poor coal. The nitrogen in the Ipswich gas belongs there by the nature of the process; this gas is one of the four analyzed for the calorimetric tests. In this process, the Kendall, the gas is made by injecting oil, air and steam into a highly heated generator; the oxygen of the air combines with the carbon of the oil to make carbonic oxide, leaving the useless nitrogen in the gas. In some of the analyses the relative proportions of the carbon and hydrogen in the illuminants were determined; of course the illuminants are made up of a number of different gases and vapors, and these figures simply show the relation of the carbon and hydrogen, and thus enable us to estimate the probable heating value of this part of our gas.

	Candle-power.	Specific Gravity.	Illuminants.	Marsh Gas.	Hydrogen.	Carbonic Oxide.	Nitrogen.	Oxygen.	Carbonic Acid.	Illuminants.	
										Carbon Hydrogen, Ratio.	B. T. U.
Arlington, . . .	18.9	.444	6.03	41.00	45.37	6.89	0.71	–	–	$C_{2.63}\ H_{5.44}$	1,969.0
Boston, ...	27.3	.694	16.64	18.93	31.80	26.98	2.84	–	2.81	$C_{2.48}\ H_{5\ 62}$	1,937.3
Brookline, . . .	24.5	–	15.43	19.57	31.80	27.88	2.12	–	3.20	$C_{2.54}\ H_{5.36}$	2,000.5
Cambridge, . . .	–	–	7.56	35.63	48.07	5.15	2.35	0.10	1.14	–	–
East Boston, . . .	13.4	.380	5.31	36.56	50.06	6.81	1.26	–	–	–	–
Framingham, . .	20.9	–	14.24	15.75	36.45	22.28	4.86	–	6.42	–	–
Ipswich, ...	24.0	.691	17.78	25.81	25.02	6.18	23.30	–	1.87	$C_{2.38}\ H_{5.25}$	1,835.3
Marblehead, . . .	17.3	.436	4.09	39.25	47.07	8.06	0.39	–	1.14	$C_{2.92}\ H_{6.79}$	2,310.5
Malden, ...	19.0	–	10.21	29.75	43.30	12.03	2.54	–	2.17	–	–
Roxbury, . . .	19.7	–	13.28	19.47	33.32	28.10	2.18	0.35	3.30	–	–

The heat units of the following gases were determined by the Junker calorimeter, and the theoretical values calculated from the analyses. The British thermal unit is the amount of heat required to raise one pound of water one degree F. From the observed values, or gross units, is subtracted the number of units of heat given up by the condensation of the steam formed by the combustion of the hydrogen; this gives the "net" units. These results, given below, for gas measured, saturated with moisture, at 60 degrees F. and 30 inches barometer, form the proper standard from which to calculate the efficiency of gas engines, or the amount of gas required for any given heating purpose.

In the first column is given the "net" units, as found by the calorimeter; in the second, the number of units from condensation; which added to the first column, gives the third column, of gross units; in the fourth column are the heat values, as calculated from the analyses.

	Net B. T. U. from Calorimeter.	B. T. U. from Condensation.	Gross experimental B. T. U.	B. T. U. as calculated from Analyses.
Arlington, . . .	646.5	59.5	706.0	707.1
Boston, ...	665.8	41.5	707.3	708.4
Ipswich, ...	639.0	59.0	698.0	691.4
Marblehead, . . .	612.8	58.2	671.0	674.2

The analyses, with candle-powers, specific gravities and illuminants formulæ, are given in the table of analyses. The Arlington gas was a coal gas, with 10 per cent. cannel enricher. The Boston gas was a water gas, as supplied to the inspector's office. The next two samples are interesting in comparison. The Marblehead gas was made from coal, with no enricher, at a low heat, the yield being about 4 feet to the pound; the marsh gas is high, and the nitrogen and carbonic acid low, while the illuminants are rich and of good light and heat giving qualities. The Ipswich gas, containing more than four times the amount of illuminants, gives 38.7

per cent. more light and only 4.3 per cent. more heat. This shows that candle-powers and specific gravities cannot be used from which to figure the relative heating values of gases. It is to be noticed that the heating value of gas, as usually given, figured from analysis, is for dry gas at 32 degrees F. and 29.92 inches barometer, and is approximately 100 units higher than these "net" results.

The assistant inspector, Mr. L. S. James, has done his share of inspections and office work creditably.

Respectfully submitted,

CHARLES D. JENKINS.